NUTRITION BASICS: MACRONUTRIENTS, MICRONUTRIENTS & HYDRATION
A nutrient is a chemical substance in food that contributes to the survival and growth of an organism.

The 6 Nutrients we will be discussing in this introductory lecture are:

- Carbohydrates
- Lipids
- Protein
- Vitamins
- Minerals
- Water
RELATIONSHIP BETWEEN NUTRITION & FITNESS

Modifiable

Non-modifiable
• Calories are a unit of measurement
• A measure of food energy
• Often denoted on food labels as:
  • Calories per serving
  • kcal per 100 g
• Foods provide varying levels of nutrition for their calorie content

Example:

Turkey sandwich + apple + cheese (3 cubes) = ~660 kcal

Medium Pepperoni Pizza = ~1700 calories
Based on several factors:

- Body size
- Body composition
- Type of training

5-8 calories/minute for normal activities of daily living

Account for additional caloric expenditure based on type and length of training

Gordon & Wardlaw. Contemporary nutrition 6th ed. 2004
What drains our batteries?

Total Energy Expenditure
1) Resting Metabolic Rate (RMR)
2) Non-Exercise Activity
   Thermogenesis (NEAT)
3) Thermic Effect of Food (TEF)
4) Exercise
Positive vs. Negative

- Calorie Balance
- Negative Calorie Balance (Calorie Deficit)
- Positive Calorie Balance (Calorie Surplus)
# Reading a Food Label

**Nutrition Facts**

8 servings per container

**Serving size** 2/3 cup (55g)

<table>
<thead>
<tr>
<th>Amount per serving</th>
<th>Calories</th>
<th>230</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Daily Value*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Fat</td>
<td>8g</td>
<td>10%</td>
</tr>
<tr>
<td>Saturated Fat</td>
<td>1g</td>
<td>5%</td>
</tr>
<tr>
<td>Trans Fat</td>
<td>0g</td>
<td>0%</td>
</tr>
<tr>
<td>Cholesterol</td>
<td>0mg</td>
<td>0%</td>
</tr>
<tr>
<td>Sodium</td>
<td>160mg</td>
<td>7%</td>
</tr>
<tr>
<td>Total Carbohydrate</td>
<td>37g</td>
<td>13%</td>
</tr>
<tr>
<td>Dietary Fiber</td>
<td>4g</td>
<td>14%</td>
</tr>
<tr>
<td>Total Sugars</td>
<td>12g</td>
<td>20%</td>
</tr>
<tr>
<td>Includes 10g Added Sugars</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protein</td>
<td>3g</td>
<td></td>
</tr>
</tbody>
</table>

- Vitamin D 2mcg 10%
- Calcium 260mg 20%
- Iron 8mg 45%
- Potassium 240mg 6%

*The % Daily Value (DV) tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.
### Reading a Food Label

**Nutrition Facts**

<table>
<thead>
<tr>
<th>Serving size</th>
<th>2/3 cup (55g)</th>
</tr>
</thead>
</table>

**Amount per serving**

<table>
<thead>
<tr>
<th>Calories</th>
<th>230</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Fat</th>
<th>8g</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbohydrate</td>
<td>37g</td>
</tr>
<tr>
<td>Protein</td>
<td>3g</td>
</tr>
</tbody>
</table>

**Calories**

<table>
<thead>
<tr>
<th>Calories</th>
<th>230</th>
</tr>
</thead>
</table>

- **Total Fat**: 8g (10% Daily Value)
- **Saturated Fat**: 1g (5% Daily Value)
- **Trans Fat**: 0g (0% Daily Value)
- **Cholesterol**: 0mg (0% Daily Value)
- **Sodium**: 160mg (7% Daily Value)
- **Total Carbohydrate**: 37g (13% Daily Value)
- **Dietary Fiber**: 4g (14% Daily Value)

**Additional Information**

- 1g fat = 9 calories
- 1g Carb = 4 calories
- 1g Protein = 4 calories

*The % Daily Value (DV) tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.*
Cells cannot directly use glucose or triglycerides for energy.

Must be converted to adenosine triphosphate (ATP).

Muscle can store only a small amount of ATP (2-4 seconds worth).

Muscle can also store a small amount of Pi to regenerate ATP quickly (~5 seconds).

\[
\text{Carbohydrates} \quad \text{Lipids} \quad \text{Protein}
\]

Can be used to make ATP

\[
\text{ADP} + \text{Energy from food} + \text{Pi} \rightarrow \text{ATP}
\]

\[
\text{ATP} \rightarrow \text{Energy to do work} + \text{ADP} + \text{Pi}
\]
Carbohydrates = **4** calories per gram

Made up of carbon, hydrogen, and oxygen ($C_6H_{12}O_6$).

**In plants**
- CHO = Sugars
- Starches
- Fibre

**In the body**
- Glucose (in the blood)
- Glycogen (in the liver and muscle)

Carbohydrates are commonly known as a source of energy for the body.
CHO Recommended Daily Allowance (RDA) = 130 g/day

Food and Nutrition Board recommends = 45-65% of total caloric intake

Nutrition facts label uses its own standard = 60% of calories

This includes fiber:

Adequate intake (AI):

25 g/d  
Women

38g/d  
Men

Gordon & Wardlaw. Contemporary nutrition 6th ed. 2004
GLUCOSE = Most useful form of CHO fuel for muscle

Stored as GLYCOGEN

Maintains blood glucose

Supplies glucose for fuel to muscles

Vigorous exercise > 1 hour = CHO needs
Protein = 4 calories per gram

Proteins are involved in:
• Blood clotting
• Fluid balance
• Hormone production
• Enzyme production
• Cell repair
• Connective tissues
• Neurotransmitters
• and many more!
What does 0.8 g/kg/day of protein look like?

Recommended Daily Allowance (RDA) = 0.8 g/kg/day

Food and Nutrition Board recommends = 10-35% of total caloric intake

Nutrition facts label uses its own standard = % Daily value (DV) listed only if there is a high protein claim

60 kg person = 48 g protein/day

85 kg person = 68 g protein/day
Protein contributes very little to fuel during exercise.

The exception to this is during prolonged endurance exercise!
Fat = 9 calories per gram

Fats serve several important functions in the body:

• Make up lipid membranes
• Help to transport vitamins
• Energy storage
• Required to produce sex hormones

Saturated fats:
- Straight fatty acid tails
- Solid at room temperature
  (ex. Butter)

Unsaturated fats:
- Bent fatty acid tails (due to double bond)
- Tend to be liquid at room temperature
  (ex. Olive oil)

Trans fats:
- Contain trans double bonds
- Rare in nature (produced during partial hydrogenation)
- Solid at room temperature
  (ex. shortening)
Recommended Daily Allowance (RDA) = there is NO RDA

Food and Nutrition Board recommends = 20-35% of total caloric intake

Nutrition facts label uses % DV = >20 g of saturated fat
Glycerol backbone 3 Fatty Acids

Taken to the blood stream and broken down

The more fatty acids in the blood stream, the more can be taken up by muscle and used for fuel.

Some fat can be stored in the muscle (intramuscular triglycerides [IMTG]) to be used quickly for fuel.
Vitamins = 0 calories per gram

- Are required for normal function, growth and maintenance
- Assist in chemical reactions

Can come from:

\[ \text{Plant} \quad \text{or} \quad \text{Animal} \]

Are categorized by solubility:

\[ \text{Fat} \quad \text{vs.} \quad \text{Water} \]

In order to be classified as a vitamin:

1. The body is not able to synthesize enough of the nutrient to maintain health
2. Prolonged absence of the nutrient produces deficiency symptoms
### Fat Soluble Vitamins

<table>
<thead>
<tr>
<th>Vitamin</th>
<th>Major Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitamin A</td>
<td>Promote vision: night and color; promote resistance to bacterial infection and overall immune system through mucus production; promote growth; prevent drying skin and eyes; antioxidant; acne treatment</td>
</tr>
<tr>
<td>(preformed vitamin A and provitamin A)</td>
<td></td>
</tr>
<tr>
<td>Vitamin D</td>
<td>Increase absorption of calcium and phosphorus; Maintain optimal blood calcium and calcification of bone; skin development</td>
</tr>
<tr>
<td>Vitamin E</td>
<td>Antioxidant: prevents breakdown of vitamin A and unsaturated fatty acids; improves vitamin A absorption; metabolizes iron in cells; maintains nervous tissue and immune function</td>
</tr>
<tr>
<td>Vitamin K</td>
<td>Activation of blood-clotting factors, Activation of proteins involved in bone metabolism</td>
</tr>
</tbody>
</table>
### Water Soluble Vitamins

<table>
<thead>
<tr>
<th>Vitamin</th>
<th>Major Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thiamin (vitamin B-1)</td>
<td>Coenzyme of carbohydrate metabolism; nerve function</td>
</tr>
<tr>
<td>Riboflavin (vitamin B-2)</td>
<td>Coenzyme of oxygen requiring pathways like fatty-acid breakdown, homocysteine metabolism</td>
</tr>
<tr>
<td>Niacin (vitamin B-3)</td>
<td>Used by almost all metabolic pathways; coenzyme of energy metabolism; makes new compounds; coenzyme of fat synthesis</td>
</tr>
<tr>
<td>Pantothenic Acid (vitamin B-5)</td>
<td>Coenzyme of energy metabolism from carbs, fat, and protein; coenzyme of fat synthesis; coenzyme of fat breakdown</td>
</tr>
<tr>
<td>Vitamin B-6 (pyridoxine)</td>
<td>Coenzyme for numerous enzymes of carb, fat, and especially in protein metabolism by splitting nitrogen group from amino acid; neurotransmitter synthesis; hemoglobin synthesis; white blood cell synthesis</td>
</tr>
<tr>
<td>Biotin (vitamin B-7)</td>
<td>Coenzyme of glucose production and fat synthesis by adding carbon dioxide to other compounds</td>
</tr>
<tr>
<td>Folate (vitamin B-9)</td>
<td>Coenzyme involved in DNA synthesis to help form new red blood cells by supplying/accepting single carbon compounds; helps form neurotransmitters in the brain to help with depression</td>
</tr>
<tr>
<td>Vitamin B-12 (Cobalamin)</td>
<td>Coenzyme of folate metabolism in that it converts folate to its active form; maintains myelin sheaths to insulate neurons from each other and maintain nerve function; homocysteine metabolism</td>
</tr>
<tr>
<td>Vitamin C (Ascorbic Acid)</td>
<td>Collagen synthesis for connective tissue and wound healing; hormone synthesis; neurotransmitter synthesis; possible antioxidant activity; reduces destruction of folate; increases iron absorption; immune system and defense versus common cold</td>
</tr>
<tr>
<td>Choline</td>
<td>Part of acetylcholine which is a neurotransmitter; part of lecithin which is a phospholipid; homocysteine metabolism</td>
</tr>
</tbody>
</table>

Gordon & Wardlaw. Contemporary nutrition 6th ed. 2004
Minerals = 0 calories per gram

- The only inorganic nutrient
- Can function independently or as part of a mineral combination (ex. Bone minerals)

Animal sources are absorbed better than plant sources

Plant sources:
- Contain fibre and binders (hinders absorption)
- Rely on minerals from the soil (poor soil = poor plant minerals)
- Refined plant foods have lower mineral contents

Classified as: Major vs. Trace

Gordon & Wardlaw. Contemporary nutrition 6th ed. 2004
<table>
<thead>
<tr>
<th>Mineral</th>
<th>Major Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium</td>
<td>Major positive ion of extracellular fluid; fluid/water balance and retention; aids nerve impulse transmission; absorption of nutrients like glucose</td>
</tr>
<tr>
<td>Potassium</td>
<td>Major positive ion of intracellular fluid; fluid/water balance; lowers blood pressure; aids nerve impulse transmission</td>
</tr>
<tr>
<td>Chloride</td>
<td>Major negative ion of extracellular fluid; fluid/water balance; participates in acid production in stomach; aids nerve impulse transmission; used by white blood cells when attack foreign cells</td>
</tr>
<tr>
<td>Calcium</td>
<td>Bone and tooth structure; blood clotting; aids in nerve impulse transmission; muscle contractions</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>Major ion of intracellular fluid; bone and tooth strength (mostly found here); part of various metabolic compounds involved in energy metabolism; component of enzymes, DNA, and cell membranes</td>
</tr>
<tr>
<td>Magnesium</td>
<td>Bone formation; aids in over 300 enzyme functions; aids nerve and heart function; required in energy-yielding compounds like insulin</td>
</tr>
<tr>
<td>Sulfur</td>
<td>Part of vitamins and amino acids; aids in drug detoxification in the liver; acid/base balance</td>
</tr>
<tr>
<td>Mineral</td>
<td>Major Functions</td>
</tr>
<tr>
<td>------------</td>
<td>---------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Iron</td>
<td>Components of hemoglobin, myoglobin, and other key compounds used in respiration; part of enzymes, proteins, and compounds used in energy; immune function; cognitive development; detoxification in liver; bone health</td>
</tr>
<tr>
<td>Zinc</td>
<td>Required for nearly 200 enzymes; alcohol metabolism; growth; immunity; wound healing; sexual development; reproduction; antioxidant protection (component of 2 forms of superoxide dismutase); may function in reduction of macular degeneration</td>
</tr>
<tr>
<td>Selenium</td>
<td>Part of an antioxidant system; thyroid hormone metabolism</td>
</tr>
<tr>
<td>Iodide</td>
<td>Component of thyroid hormones</td>
</tr>
<tr>
<td>Copper</td>
<td>Involved in iron metabolism by aiding the enzyme that releases iron from storage and operates in a process that transports iron and forms hemoglobin; used in enzymes that create cross-links in connective tissue; used in enzymes that defend against free radicals (such as SOD) or other enzymes of the brain and nervous system; immune function; blood clotting; blood lipoprotein metabolism; involved with enzymes of protein metabolism and hormone synthesis</td>
</tr>
<tr>
<td>Fluoride</td>
<td>Increases resistance of tooth enamel against acids and bacteria that cause dental caries</td>
</tr>
<tr>
<td>Chromium</td>
<td>Enhances insulin action to enhance glucose uptake to cells</td>
</tr>
<tr>
<td>Manganese</td>
<td>Often substituted with magnesium in metabolic processes; cofactor of some enzymes such as those involved in carbohydrate metabolism; works with some antioxidant systems (such as SOD); important in bone formation</td>
</tr>
<tr>
<td>Molybdenum</td>
<td>Aids in action of several enzymes</td>
</tr>
</tbody>
</table>

Adapted from Gordon & Wardlaw. Contemporary nutrition 6th ed. 2004
Recommendations are similar to those to sedentary adults.

Athletes on low calorie diets (>1200 kcals) or vegetarians should consume fortified foods or a multi vitamin.

Antioxidant rich diets (vitamins E and C) may be beneficial for athletes.

Consume brightly colored fruits and vegetables.
Water ($H_2O$) is the greatest component of the human body.

Used as a solvent in the body

Makes up approximately 50 - 70% of body mass

~ 10 gallons
~ 40 liters
~ 165 cups of water

Muscle is 73% water
Adipose is 20% water

2.7 g of water is stored for every 1 g of glycogen

Gordon & Wardlaw. Contemporary nutrition 6th ed. 2004
Water is a very important nutrient and has several functions in the body:

• Is a medium of chemical processes
• Transports nutrients
• Is the basis for many body fluids - especially joints (both a solvent and lubricant), saliva, and bile
• Is a medium for temperature regulation
• Aids in the removal of waste products

Water is ideal for removing body heat because it requires lots of energy to heat.

Unusable substances can be dissolved in water to be excreted.

Our kidneys are responsible for filtering out waste into urine.
KEY TAKEAWAYS

✓ Calories and energy come in different forms from food
  • Carbohydrate, protein and fat all provide different amounts of calories
  • Athlete requirements may be different from the general population
    o Greater energy requirements (to avoid negative energy balance)
    o Greater need for protein (repair)
    o Greater need for CHO (fuel)

✓ There are various types of macronutrients and micronutrients:
  • Consuming a balanced diet is the best way to ensure adequate intake

✓ Athletes! Don't skip on hydration!